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(54) (Title of the Invention) COMPOSITE MATERIAL

(57) (Summary)

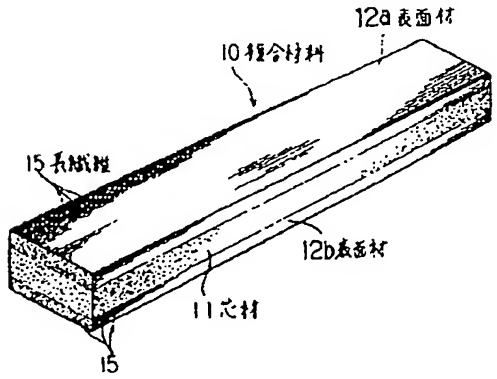
(Purpose)

The main purpose of this invention provide a composite material that has the same light weight as wood as well as excellent physical properties.

(Constitution)

Composition material 19 is provided with a sandwich structure having a core material 11 made of thermosetting resin foam such as rigid urethane resin foam, and surface materials 12a, 12b laminated in an integrated manner at one side as well as at the side opposite thereto of the core 11. The surface materials 12a, 12b are FRP materials in which the same thermosetting resin foam that is identical to the core material 11 is reinforced with FRP by unidirectional, longitudinal fibers 1, wherein a long fiber 15 is arranged along the longitudinal direction of the composition material 10. Further, the density of these surface materials 12a, 12b is greater than that of the core material 11.

10 composite material
11 core material
12a surface material
12b surface material
15 long fiber



[page 2]

(Scope of the Patent's Claims)

(Claim 1)

A composite material, characterized by the fact that it is equipped with a core material that is made of thermosetting resin foam, and a surface material, so that at least one face side is laminated on this core material and integrated with the face side opposite thereto;

wherein said surface material is made of a fiber-reinforced resin, reinforced by a long

fiber along the longitudinal direction of the surface material in the thermosetting fiber foam.

(Claim 2)

The composite material of claim 1, characterized by the fact that a glass fiber is used for said long fiber; and that the content ratio of this long fiber is from 10 to 35 weight % of the total amount of the composite material; while the ratio of said surface material in the total amount of the composite material is from 30 to 70 volume %.

(Claim 3)

The composite material of claim 1, characterized by the fact that at the most 50 weight % of a filler agent are added to said thermosetting resin foam.

(Claim 4)

The composite material of claim 1, characterized by the fact that the hardness of the surface material at least on one side of the surface materials deployed on the upper side and on the lower side of said core material is less than 17 kgf.

(Claim 5)

The composite material of claim 1, characterized by the fact that the hardness of said core material is less than 17 kgf.

(Claim 6)

The composite material of claim 1, characterized by the fact that an organic fiber is used as a reinforcing fiber in the surface material at least on one side in the surface materials deployed on the upper side and on the lower side of said core material.

(Claim 7)

The composite material of claim 1, characterized by the fact that a mixture using a glass fiber and an organic fiber is used as a reinforcing fiber in the surface material at least on one side of the surface materials deployed on the upper side and on the lower side of said core material.

(Detailed Explanation of the Invention)

(0001)

(Field of Industrial Use)

The present invention relates to a composite material that is suitable for example as a

construction material, for instance in various types of frame boards and other construction materials, or that can be used for scaffold boards, for railroad crossties and for similar purposes.

(0002)

(Prior Art Technology)

Although wood and concrete are materials that have been widely used as construction materials, it is often said that the problem with wood is that it is easily susceptible to rotting and damage, and that its physical properties can be damaged due to water absorption, while its durability characteristics are also inferior. A stable supply of wood is also a problem due to insufficient supplies of raw materials. Although concrete is a raw material that is easily available, unlike wood, the problem here is that concrete is very heavy. To deal with this problem, composite materials that are reinforced with longitudinal fibers containing a resin foam material have been proposed in the last few years, as one can see for example from Japanese Utility Model Application Number 61-23042.

(0003)

(Problems To Be Solved By This Invention)

However, because the bending strength of the composite materials consisting of a simple foam resin and fibers of the type mentioned in connection with prior art was sometime not sufficient depending on what they were used for, characteristics such as the rigidity of such materials used in thick products, or their compression strength, weight, molding characteristics and the like still need to be improved.

(0004)

Further, since crossties employed in the composite materials used according to prior art for the railroad bed were rigid, it was difficult for gravel to cut into such materials and the crossties were prone to slippage sideways. This created problems related to lateral slippage because the centrifugal force is particularly strong especially when railroad cars are passing through the curves of a railroad.

In addition, the processing characteristics of conventional composite materials were poor because a long time was required for processing, they suffered from extensive equipment damage, spraying of fine powder was generated during cutting, etc. Therefore, the purpose of this invention is to provide a composite material that is not only very light and highly rigid, but that is also highly resistant and offers superior processing characteristics, etc.

(0005)

(Means To Solve Problems)

In order the achieve the above mentioned objectives, the composite material developed according to this invention is created with the sandwich construction, equipped with a core material made of thermosetting resin foam, and with a surface material laminated in an integrated manner at least on one side face of this core material and on the opposite side face.

(0006)

Taking into consideration light weight characteristics, as well as physical properties and other characteristics, a rigid, urethane resin foam material, whose density is in the range of 0.4 ~ 0.6 g/cm^2 is suitable for said core material. The density range is limited in this manner because a compression resistance that is identical to or better than that of wood and a lightweight design that is identical to or better than that of wood must be obtained. This core material can be also filled with a suitable filler agent.

(0007)

For the surface material is used a matrix containing the same thermosetting resin foam material as that of the core, and this matrix is filled with a unidirectional, longitudinal fiber made of glass, etc. The content amount of the fiber in the surface materials is in the range of 30 ~ 50 weight % and its density is in the range of 0.57 ~ 0.9 g/cm3. The range is limited in this manner because this range enables a sufficient bending strength in the vicinity of the surface of a material having a large distribution of bending strength, while the same lightweight design, etc., as that of wood can be achieved at the same time. A rigid urethane resin foam material that is identical to the core material is suitable for the resin to be employed in the surface material. For the long fiber can be used a suitable fiber such as a glass fiber, or a carbon fiber, or another suitable organic or synthetic fiber can be employed. Taking into account economic characteristics, the most suitable type of fiber, is a glass fiber.

(0008)

The composite ratio of said surface material and said core material, that is to say the ratio of the surface material and of the core material contained in the all of the composite material is 30 ~ 70 volume % of the core material, while the fiber content amount in all of the composite material should be in the range of 10 ~ 35 weight %. Also, if the density of all of the composite material is less than 0.065 g/cm^3, this makes it possible to achieve light weight that is comparable to that of wood.

(0009)

(Operation)

The composite material of the present invention has a sandwich construction comprising a surface material having not only a light weight combined with a high rigidity and a high tensile

strength, but also a light weight that is identical to or better than that of wood and an excellent bending strength and compression strength, as well as high rigidity of the composite material. Moreover, it is as easy to drive nails into this material as when nails are driven into wood. Further, since the water absorption amount is very low, the physical properties of this material are stable and they can be easily maintained. Furthermore, because a sandwich construction is created comprising a core material and a surface material, this makes it possible to attain an optimal vibration absorption capacity, as well as sound proofing and heat insulating characteristics, which means that the product can be also manufactured with the required thickness of this product.

(0010)

The following is an explanation of one embodiment of the present invention based on the reference provided in the figures. As shown in the examples illustrated by Figure 1 and Figure 2, the composite material 10 of the present embodiment is formed with a sandwich construction, equipped with a core material 11, which is made of thermosetting resin foam material such as rigid urethane foam or a similar material, surface material 12a, laminated on one surface side of the core 11 (not shown in the figure), and surface material 12b, which is laminated on the opposite surface side (the lower surface side in the example shown in the figure).

[page 3]

(0011)

The surface materials 12a, 12b are fiber-reinforced synthetic resin materials (FRP), reinforced with long fiber 15 (shown only partially in the figure) which is drawn in one direction, containing a rigid resin urethane foam material or the like identical to the material used in the core material 11, while the long fiber 15 is arranged along the longitudinal direction of the composite material 10. Glass is suitable for the material of the long fiber 15 for economical reasons, although other materials can be also used, such as alamid fiber or another organic fiber, or carbon fiber or the like. The density of the surface materials 12a, 12b is greater than that of the core material 11.

(0012)

In order to manufacture said composite material, the aggregate of the long fiber 15 is arranged in a desired amount, for example inside a forming die for formation of surface material, and foam molding is performed so that the aggregate of this long fiber 15 is dipped in a raw material liquid of urethane resin foam. The density of the foam can be adjusted to any value corresponding to the amount of the raw material liquid, as well as to the foaming agent, etc.

(0013)

After the surface materials 12a, 12b have been formed, they are arranged inside the

forming die and the urethane foam raw material liquid is injected into the die for the core material 11 and foam molding is performed so that surface materials 12a, 12b containing the core material 11, are formed in an integrated manner. Since the surface materials 12a, 12b are in this case mutually integrated via a urethane resin with the core material 11 during foam molding of the core material 11, there is no need to perform bonding operations during a separate stage.

(0014)

In addition, the core material 11 can be also formed in advance. In this case, the aggregate for the long fiber 15 is piled up in one direction in the longitudinal direction along both faces of the core material 11, formed inside the die, and the composite material is obtained with the sandwich construction, wherein the surface materials 12a, 12b are integrated with the core material 11 by performing foam molding inside a die that has been dipped in the raw material liquid of urethane resin foam material for the surface materials 12a, 12b of the aggregate of the long fiber 15. The density of the foam material can be adjusted also in this case to any value in accordance with the amount of the liquid, etc.

(0015)

It is further also possible to add at the most 50 weight % of a filler material that is easily available to said thermosetting resin foam. For the filler material can be used for example calcium carbonate, sawdust, or similar material. If the amount of the filler exceeds the above-mentioned range, the viscosity of the raw material liquid for the thermosetting resin foam will be increased, which will make the molding process difficult. It is therefore necessary not to exceed the values mentioned above.

(0016)

Table 1 below list the results of a comparative measurement of the physical properties of the composite material 10 (a product of the present invention) and of beach wood. Figures 3 and 4 are graphs indicating the relationship between the specific gravity of the composite material 10 and the bending characteristics. Beach wood is a material that is commonly used for crossties, as well as for construction material. The dimensions of the test piece were as follows: both the width and the thickness was 30 mm, while the span was set to 420 mm. The thickness of the surface materials 12a, 12b was 7.5 mm.

(0017)

(Table 1)

	Product of This Invention	Beech Wood
Fiber content ratio (Wt %)	19	-
Skin material density (g/cm^3)	0.77	-
Core material density (g/cm^3)	0.50	-
Core material composite ratio (Vol. %)	50	
Material density (g/cm^3)	0.64	0.65 ~ 0.84
Bending elastic modulus (Kgf/mm^2) (JIS Z2113)	710	710
Bending strength (Kgf/mm^2) (JIS Z2113)	9.3	8.0
Lateral compression ratio example (Kgf/mm^2) (JIS Z211)	1.2	0.8
Water absorption amount (g/cm^2) (JIS Z2104)	2	140

(0018)

In addition, in the surface materials 12a, 12b can be also contained a fiber in a direction that is different from that of the long fiber 15. Further, the surface materials 12a, 12b can be also deployed on other surfaces than the two surfaces mentioned above, for example in the inner surface part, etc.

[page 4]

(0019)

When the composite material is utilized for a railroad bed, it is best to use a soft surface material 12 on the lower side. One means that can be employed for this purpose is an elastic urethane foam. Specifically, it is possible to use for example a means wherein a glass fiber is contained in the rigid urethane foam having a hardness of less than 17 kgf (based on the JISZ 2117 standard), or a means wherein a glass fiber is contained in a semi-rigid foam. In addition, it is also possible to use a design decreasing the content amount of the glass fiber. A combination of several such means can be also employed.

(0020)

When the hardness of the surface material 12b on the lower side is reduced in this manner, penetration of gravel in a railroad bed into the surface material 12b on the lower side is facilitated. Therefore, this makes it possible to prevent lateral slippage of a crosstie and to increase the vibration resistance capability.

(0021)

Lateral slippage of crossties can be also prevented when a soft design of the core material 11 is used. In concrete terms, one can use rigid urethane foam having a hardness of less than 17 kgf (based on the JISZ 2117 standard), or semi-rigid urethane foam. In this case, the volume of the core material 11 should be less than 50%. In this manner, because the gravel on a railroad bed will be driven into the side face of an elastic core material 11, lateral slippage of crossties can be prevented, while the vibration resistance capability is increased at the same time.

(0022)

In order to improve the processing characteristics of said composite material 10, a reinforcement fiber can be used in the surface materials 12a, 12b, and a soft organic fiber can be used instead of a rigid glass fiber, or it is also possible to use a mixture of a glass fiber with an organic fiber. Materials that are suitable for organic fibers are polyester fibers, as they make it possible to strike a good balance with respect to the cost-performance ratio, or cotton. As far as the mode of the fiber is concerned, while continuous mode is recommended, a short fiber longer than 20 mm can be also used.

(0023)

Since the quantity of a hard rigid glass fiber will be reduced if organic fibers are used as mentioned above, this provides for good processing characteristics. Because a front hole for driving in spikes can be formed up to the core material 11 in a railroad crosstie, and said organic fiber can be used on the upper side of the surface material 12a, the problem of processing characteristics can thus be resolved in this manner.

(0024)

In addition, although a sandwich construction with three layers comprising a core material 11 and surface materials 12a, 12b was employed in each of the embodiments above, it is also possible to realize the present invention with a sandwich construction having 4 or more layers, depending on the case.

(0025)

(Effect of the Invention)

The composite material of the present invention makes it possible to provide a material that is as light as or lighter than wood, which has a high rigidity and optimal durability, while making it possible to reduce the amount of absorbed water, as well as to maintain stable physical property values. Moreover, since the processing is easy and nails can be driven into the material thanks to the excellent soundproofing, vibration resistance and thermal insulation characteristics,

the composite material displays an excellent overall effect.

(Brief Explanation of Figures)

(Figure 1)

A perspective view of a composite material showing one embodiment of the present invention.

(Figure 2)

A profile view of the composite material shown in Figure 1.

(Figure 3)

A graph indicating the relationship between the specific gravity and the bending elastic modulus of a composite material according to this invention.

(Figure 4)

A graph indicating the relationship between the specific gravity and the bending strength of a composite material according to this invention.

(Explanation of Symbols)

10 ... composite material, 11 ... core material, 12a, 12b ... surface materials, 15 ... long fiber.

(Procedural Amendment)

(Filing Date) March 11, 1992

(Procedural Amendment 1)

(Name of the Subject Document for Amendment) Specifications

(Names of Items for Amendment) Scope of the Patent's Claims

(Amending Method) Change

(Amendment Content)

(Scope of the Patent's Claims)

(Claim 1)

A composite material, characterized by the fact that that it is equipped with a core material that is made of thermosetting resin foam only, or includes a filler, and a surface material, so that at least one face side is laminated on this core material and integrated with the face side opposite thereto;

wherein said surface material is made of a fiber-reinforced resin, reinforced by a long fiber along the longitudinal direction of the surface material in the thermosetting fiber foam.

(Claim 2)

The composite material of claim 1, characterized by the fact that a glass fiber is used for said long fiber; and that the content ratio of this long fiber is from 10 to 35 weight % of the total amount of the composite material; while the ratio of said surface material in the total amount of the composite material is from 30 to 70 volume %.

(Claim 3)

The composite material of claim 1, characterized by the fact that at the most 50 weight % of a filler material are added to said thermosetting resin foam.

(Claim 4)

The composite material of claim 1, characterized by the fact that an organic fiber is used as a reinforcing fiber in the surface material at least on one side in the surface materials deployed on the upper side and on the lower side of said core material.

(Claim 5)

The composite material of claim 1, characterized by the fact that a mixture comprising an organic fiber and a glass fiber is used as a reinforcing fiber in the surface material at least on one side in the surface materials deployed on the upper side and on the lower side of said core material.

(Procedural Amendment 2)

(Name of Amended Document) Specifications

(Item Subject to Amendment) 0005

(Amending Method) Change

(Amendment Content)

(00005)

(Means To Solve Problems)

In order the achieve the above mentioned objectives, the composite material developed according to this invention is created as a sandwich construction equipped with a core material made of thermosetting resin foam only, or containing a filler, and with a surface material laminated in an integrated manner at least on one side face of this core material and on the opposite side face.

(Procedural Amendment 3)

[page 5]

(Name of Amended Document) Specifications

(Item Subject to Amendment) 0015

(Amending Method) Change

(0015)

It is further also possible to add at the most 50 weight % of a filler material that is easily available to said thermosetting resin foam. For the filler material can be used for example calcium carbonate, sawdust, or a short glass fiber having a length from 10 mm ~ 50 mm, or similar material. If the amount of the filler exceeds the above-mentioned range, the viscosity of the raw material liquid for the thermosetting resin foam will be increased which will make the molding process difficult. It is therefore necessary not to exceed the values mentioned above.

(Procedural Amendment 4)

(Name of Amended Document) Specifications

(Item Subject to Amendment) 0019

(Amending Method) Change

(0019)

When the composite material is employed for railroad bed, it is best to use a soft surface material 12 on the lower side. One means that can be used for this purpose is elastic urethane foam. Specifically, it is possible to use for example a means wherein a glass fiber is contained in

the rigid urethane foam having a hardness of less than 1.7 kgf/mm^2 (based on the JISZ 2117 standard), or a means wherein a glass fiber is contained in semi-rigid foam. In addition, it is also possible to use a design decreasing the content amount of the glass fiber. A combination of several such means can be also employed.

(Procedural Amendment 5)

(Name of Amended Document) Specifications

(Item Subject to Amendment) 0021

(Amending Method) Change

(0021)

Lateral slippage of crossties can be also prevented when a soft design of the core material 11 is utilized. In concrete terms, one can use rigid urethane foam, which has a hardness of less than 1.7 kgf/mm^2 (based on the JISZ 2117 standard), or semi-rigid urethane foam. In this case, the volume of the core material 11 should be less than 50%. In this manner, because the gravel on a railroad bed will be driven into the side face of an elastic core material 11, lateral slippage of crossties can be prevented, while the vibration resistance capability is increased at the same time.

(Procedural Amendment)

(Filing Date) December 10, 1992

(Procedural Amendment 1)

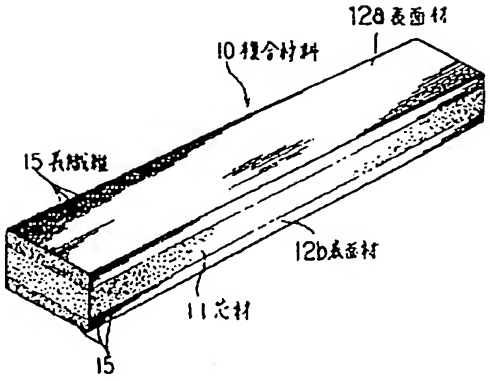
(Name of Amended Document) Figures

(Items Subject to Amendment) All Figures

(Amendment Content)

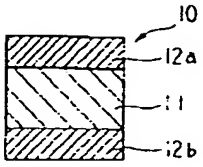
Figure 1 and Figure 2

【図１】



(Figure 1)

【図２】

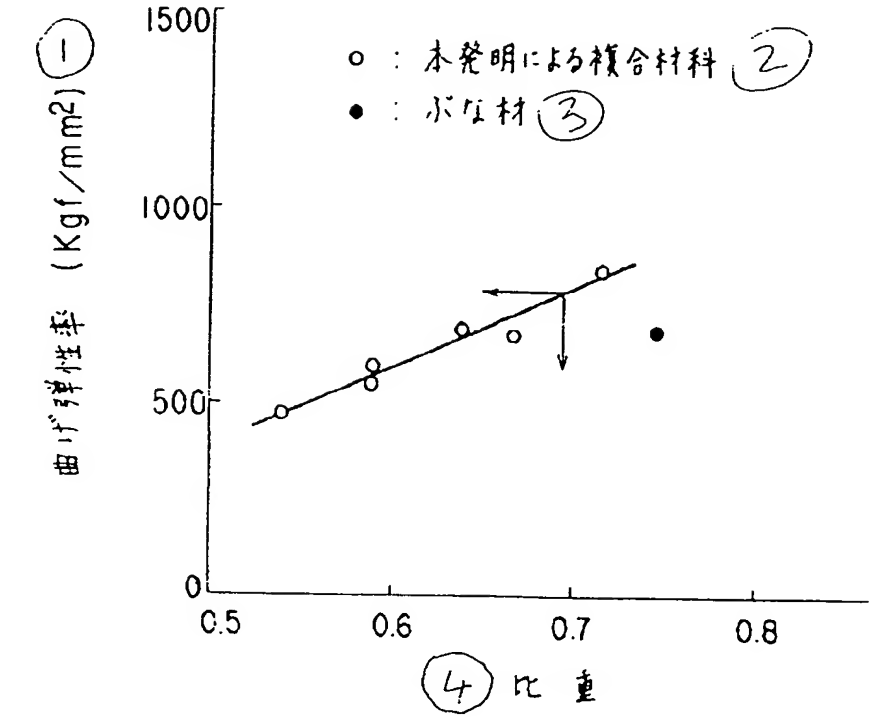


(Figure 2)

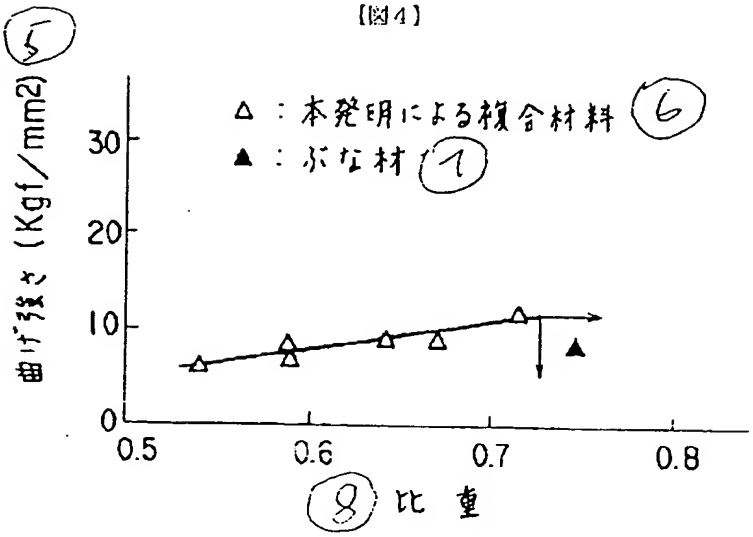
10 composite material
11 core material
12a surface material
12b surface material
15 long fiber

(Figure 3 and Figure 4)

【図3】



【図4】



(Figure 3)

1 bending elastic modulus (kgf/mm^2)
2 ○: composite material of this invention
3 ●: beech wood material
4 specific gravity

(Figure 4)

5 bending elastic modulus (kgf/mm^2)
6 Δ: composite material of this invention
7 ▲: beech wood material
8 specific gravity

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	27/20	Z	6122－4F		

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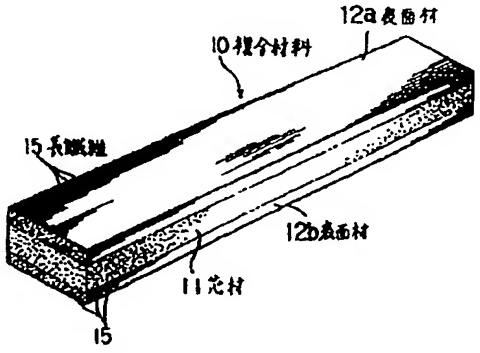
(54)【発明の名称】　複合材料

(57)【要約】

【目的】本発明の主要な目的は、軽量でかつ木材に比べて物性の優れた複合材料を提供することにある。

【構成】複合材料１０は、硬質ウレタン樹脂発泡体等の熱硬化性樹脂発泡体からなる芯材１１と、芯材１１の一面側と反対面側とに一体的に積層された表面材１２ａ，１２ｂとからなるサンドイッチ構造をなしている。表面材１２ａ，１２ｂは、芯材１１と同様の熱硬化性樹脂発泡体を一方向長繊維１５によって補強したＦＲＰであり、長繊維１５は複合材料１０の長手方向に沿っている。この表面材１２ａ，１２ｂの密度は芯材１１よりも大きい。



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【特許請求の範囲】

【請求項1】熱硬化性樹脂発泡体からなる芯材と、この芯材の少なくとも一面側と反対面側とに一体的に積層された表面材とを具備し、上記表面材は熱硬化性樹脂発泡体を表面材の長手方向に沿う長繊維によって補強した繊維強化樹脂からなることを特徴とする複合材料。

【請求項2】上記長繊維にガラス繊維が使用され、かつこの長繊維の含有率が複合材料全体で10ないし35重量%であり、しかも上記表面材が複合材料全体に占める割合が30ないし70体積%である請求項1記載の複合材料。

【請求項3】上記熱硬化性樹脂発泡体に充填剤が最大で50重量%添加されている請求項1記載の複合材料。

【請求項4】上記芯材の上側と下側に設けた表面材のうち、少くとも片側の表面材の硬さが17kgf 以下である請求項1記載の複合材料。

【請求項5】上記芯材の硬さが17kgf 以下である請求項1記載の複合材料。

【請求項6】上記芯材の上側と下側に設けた表面材のうち、少くとも片側の表面材の補強繊維として有機繊維を用いた請求項1記載の複合材料。

【請求項7】上記芯材の上側と下側に設けた表面材のうち、少くとも片側の表面材の補強繊維としてガラス繊維と有機繊維の混合物を用いた請求項1記載の複合材料。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、例えば建築資材としての各種構造材や枠板、足場板、あるいは軌道のまくらぎ等の用途に適する複合材料に関する。

【0002】

【従来の技術】木材やコンクリートは建築資材として従来から広く用いられてきたが、木材は腐食や損傷に弱く、吸水によって物性が低下するなどの難点があり、耐久性に劣るとも言われている。また、資源不足により供給安定性に問題がある。他方、コンクリート製の資材は丈夫であり入手も容易であるが、きわめて重いという欠点がある。また、防振あるいは防音性も劣っている。これらの問題に対処するために、近年、例えば実公昭61-23042号公報に見られるように、樹脂発泡体を一方向長繊維で強化した複合材料が提案されている。

【0003】

【発明が解決しようとする課題】しかしながら、上記先行技術のような単なる発泡樹脂と繊維とからなる複合材料は、用途によっては曲げ強さが不足したり、厚物製品にした時の剛性や圧縮強さ、重量、成形性などに改善すべき点があった。

【0004】また、道床軌道の場合、従来の複合材料のまくらぎは硬いので、バラスが食い込みにくく、まくらぎが横に滑りやすい。特にカーブ軌道では、車両通過時の遠心力が大きいため、まくらぎの横滑りが問題になる。しかも従来の複合材料は、加工時間が長い、工具の損傷が激しい、微粉の切り粉が飛散するなど、加工性が悪かった。従って本発明の目的は、軽量でかつ剛性が高く、しかも耐久性および加工性などに優れた複合材料を提供することにある。

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【0005】

【課題を解決するための手段】上記目的を果たすために開発された本発明の複合材料は、熱硬化性樹脂発泡体からなる芯材と、この芯材の少なくとも一面側と反対面側とに一体的に積層された表面材とを具備したサンドイッチ構造をなしている。

【0006】上記芯材は、経済性や物性などを考慮すると硬質ウレタン樹脂発泡体が適しており、その密度は0.4～0.6g/cm³ の範囲が良い。このような範囲に限定する理由は、木材と同等以上の圧縮強さを得るためと、木材と同等以上の軽量化を図るためである。この芯材に適宜の充填剤が含有されてもよい。

【0007】表面材は、芯材と同様の熱硬化性樹脂発泡体をマトリックスとして用い、これにガラス等の一方向長繊維を含有させたものである。表面材における繊維含有量は30～50重量%とし、密度を0.57～0.9g/cm³ の範囲にする。このような範囲に限定する理由は、曲げ応力分布の大きい材料表面付近での曲げ強さを十分なものにするとともに、木材と同等以上の軽さを得るためである。表面材に用いる樹脂は、芯材と同様に硬質ウレタン樹脂発泡体が適している。長繊維はガラス繊維やカーボン繊維、あるいは有機合成繊維などを適用できるが、経済性を考慮するとガラス繊維が最適である。

【0008】上記表面材と芯材の複合率、すなわちこの複合材料全体に占める表面材と芯材の割合は、芯材を30～70体積%とし、かつ複合材料全体に占める繊維含有量を10～35重量%として、複合材料全体の密度が0.65g/cm³ 以下にすれば、木材と比較して軽量なものを得ることができる。

【0009】

【作用】本発明の複合材料は、軽量で剛性および引張り強さの大きい表面材と、更に軽量で圧縮強さの大きい芯材からなるサンドイッチ構造であるから、木材と同等以上の軽量なものでありながら、曲げ強さや圧縮強さに優れ、複合材料全体としての剛性も高い。しかも木材と同様に釘を打込むことができる。また、吸水量がきわめて少なく、安定した物性値を維持できる。また、芯材と表面材とからなるサンドイッチ構造であるから、振動吸収性能や防音および断熱性に優れ、必要に応じて厚物の製品も容易に作ることができる。

【0010】

【実施例】以下に本発明の一実施例について、図面を参照して説明する。図1，2に例示するように、本実施例の複合材料10は、硬質ウレタン樹脂発泡体等の熱硬化性樹脂発泡体からなる芯材11と、芯材11の一面側

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(図示例では上面側)に積層された表面材12aと、反対面側(図示例では下面側)に積層された表面材12bとを備えたサンドイッチ構造をなしている。

【0011】表面材12a，12bは、芯材11に用いられたものと同様の硬質ウレタン樹脂発泡体等の熱硬化性樹脂発泡体を、一方向に引き揃えた長繊維15(一部のみ図示する)によって補強した繊維強化合成樹脂(FRP)であり、長繊維15は複合材料10の長手方向に沿って配置されている。長繊維15の材質は問わないが、経済的な理由からガラスローピングが適している。但し、アラミッド繊維等の有機合成繊維やカーボン繊維などが用いられてもよい。表面材12a，12bの密度は芯材11の密度よりも大きい。

【0012】上記複合材料10を製造するには、例えば表面材成形用の型の内部に所定量の長繊維15の集合体を配置し、この長繊維15の集合体にウレタン樹脂発泡体の原料液を含浸させて発泡・成形する。発泡体の密度は原料液の液量や発泡剤等に応じて任意の値に調整可能である。

【0013】表面材12a，12bを成形したのち、これを型内に配置し、芯材11用のウレタン樹脂発泡体の原料液を型に注入して発泡・成形し、芯材11を表面材12a，12bと一体化させる。この場合、芯材11の発泡・成形に伴って芯材11と表面材12a，12bが互いにウレタン樹脂を介して一体化するので、別途に接着作業を行う必要がない。

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*【0014】なお、芯材11を先に成形しておいてもよい。その場合、型内で成形した芯材11の両面に長手方向に沿って一方向長繊維15の集合体を重ね、長繊維15の集合体に表面材12a，12b用のウレタン樹脂発泡体の原料液を含浸させて型内で発泡・成形することにより、芯材11と表面材12a，12bが一体化されたサンドイッチ構造の複合材料10が得られる。この場合も、発泡体の密度は液量等に応じて任意の値に調整することができる。

【0015】また、上記熱硬化性樹脂発泡体に、安価に入手できる充填材を、最大で50重量%添加するようにしてもよい。充填材は、例えば炭酸カルシウムや、おがくずなどである。充填材の量が上記範囲を越えると、熱硬化性樹脂発泡体の原料液の粘度が増加して成形が困難になるので、充填材の量が上記の値を越えないようにする必要がある。

【0016】次表1は、上記実施例の複合材料10(本発明品)の物性と、ぶな材の物性を比較した測定結果である。図3および図4は、複合材料10の比重と曲げ特性との関係を示していそ。ぶな材は、まくらぎや建築材料に用いられている一般的なものである。試験片のサイズは、いずれも幅と厚さが30㎜、スパンを420㎜とした。表面材12a，12bの厚みは7．5㎜である。

【0017】

【表1】

	本発明品	ぶな材
繊維含有率 (Wt%)	19	—
表皮材の密度 (g/cm³)	0．77	−
芯材の密度 (g/cm³)	0．50	−
芯材複合率 (Vol．%)	50	−
材料密度 (g/cm³)	0．64	0．65~0．84
曲げ弾性率 (Kgf/mm²) (JIS Z2113)	710	710
曲げ強さ (Kgf/mm²) (JIS Z2113)	9．3	8．0
横圧縮比例限度 (Kgf/mm²) (JIS Z2111)	1．2	0．8
吸水量 (g/cm²) (JIS Z2104)	2	140

【0018】なお、表面材12a，12bに長繊維15と異なる方向の繊維が含有されていてもよい。また、表面材12a，12bは、芯材11の前記二面以外の面、例えば側面部などにも設けるようにしてもよい。

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【００１９】道床軌道に用いる場合、下側の表面材１２ｂを柔らかいものにするとよい。そのための一手段として、ウレタンフォームを弾力性のあるものにする。具体的には、硬さ１７kgf（ＪＩＳＺ　２１１７に準拠）以下の硬質ウレタンフォームにガラス繊維を含ませるとか、半硬質ウレタンフォームにガラス繊維を含ませるなどの手段があげられる。また、ガラス繊維の含有量を減らすようにしてもよい。上記複数の手段を組合わせてもよい。

【００２０】このように下側の表面材１２ｂの硬さを下げた場合には、道床のバラスが下側の表面材１２ｂに食い込みやすくなるので、まくらぎの横滑りを防止できるとともに、防振性能も向上する。

【００２１】また、芯材１１を柔らかいものにすることによって、まくらぎの横滑りを防止することもできる。具体的には、硬さ１７kgf（ＪＩＳＺ　２１１７に準拠）以下の硬質ウレタンフォームまたは半硬質ウレタンフォームを用いる。この場合、芯材１１の体積％を５０％以下にするとよい。こうすることによって、道床のバラスが、弾力のある芯材１１の側面から食い込みやすくなるため、まくらぎの横滑りを防止できるとともに、防振性能も向上する。

【００２２】前記複合材料１０の加工性を良くするために、表面材１２ａ，１２ｂに用いる補強繊維を、硬いガラス繊維の代りに柔らかい有機繊維にするとか、ガラス繊維と有機繊維との混合物にしてもよい。有機繊維の材質としては、材料コストと性能のバランスのとれたポリエステル繊維、あるいは木綿が適している。繊維の形態としては、連続繊維が推奨されるが、２０㎜以上の短繊維でも使用できる。

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【００２３】上記のような有機繊維を用いた場合、硬いガラス繊維の量が減るので、加工性が良くなる。まくらぎの場合、犬くぎを打込む先穴は、芯材１１までなので、上側の表面材１２ａに上記有機繊維を用いることで、加工性の問題を解決することができる。

【００２４】なお、前記各実施例では、芯材１１と表面材１２ａ，１２ｂとの３層のサンドイッチ構造としたが、本発明を実施するに当って、場合によっては４層以上のサンドイッチ構造にしてもよい。

【００２５】

【発明の効果】本発明の複合材料は木材と同等以上に軽量であり、剛性および耐久性が高く、木材と比べて吸水量が少なく安定した物性値を維持できる。しかも加工しやすく釘打ちも可能であり、防音・防振・断熱効果が高いなど総合的に優れた物性を発揮できる。

【図面の簡単な説明】

【図１】本発明の一実施例を示す複合材料の斜視図。

【図２】図１に示された複合材料の断面図。

【図３】本発明による複合材料の比重と曲げ弾性率との関係を示す図。

【図４】本発明による複合材料の比重と曲げ強さとの関係を示す図。

【符号の説明】

１０…複合材料、１１…芯材、１２ａ、１２ｂ…表面材、１５…長繊維。

【手続補正書】

【提出日】平成４年３月１１日

【手続補正１】

【補正対象書類名】明細書

【補正対象項目名】特許請求の範囲

【補正方法】変更

【補正内容】

【特許請求の範囲】

【請求項１】熱硬化性樹脂発泡体のみまたは充填材を含有している芯材と、この芯材の少なくとも一面側と反対面側とに一体的に積層された表面材とを具備し、上記表面材は熱硬化性樹脂発泡体を表面材の長手方向に沿う長繊維によって補強した繊維強化樹脂からなることを特徴とする複合材料。

【請求項２】上記長繊維にガラス繊維が使用され、かつこの長繊維の含有率が複合材料全体で１０ないし３５重量％であり、しかも上記表面材が複合材料全体に占める割合が３０ないし７０体積％である請求項１記載の複合材料。

【請求項３】上記熱硬化性樹脂発泡体に充填材が最大で５０重量％添加されている請求項１記載の複合材料。

【請求項４】上記芯材の上側と下側に設けた表面材のうち、少くとも片側の表面材の補強繊維として有機繊維を用いた請求項１記載の複合材料。

【請求項５】上記芯材の上側と下側に設けた表面材のうち、少くとも片側の表面材の補強繊維としてガラス繊維と有機繊維の混合物を用いた請求項１記載の複合材料。

【手続補正２】

【補正対象書類名】明細書

【補正対象項目名】０００５

【補正方法】変更

【補正内容】

【０００５】

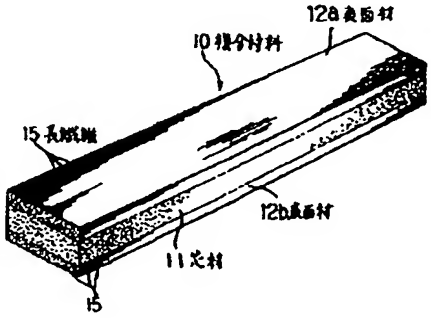
【課題を解決するための手段】上記目的を果たすために開発された本発明の複合材料は、熱硬化性樹脂発泡体のみまたは充填材を含有している芯材と、この芯材の少なくとも一面側と反対面側とに一体的に積層された表面材とを具備したサンドイッチ構造をなしている。

【手続補正３】

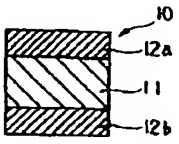
【補正対象書類名】明細書
【補正対象項目名】００１５
【補正方法】変更
【補正内容】
【００１５】また、上記熱硬化性樹脂発泡体に、安価に入手できる充填材を、最大で５０重量％添加するようにしてもよい。充填材は、例えば炭酸カルシウム、おがくず、あるいは長さ１０mm～５０mmのガラス短繊維などである。充填材の量が上記範囲を超えると、熱硬化性樹脂発泡体の原料液の粘度が増加して成形が困難になるので、充填材の量が上記の値を超えないようにする必要がある。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００１９
【補正方法】変更
【補正内容】
【００１９】道床軌道に用いる場合、下側の表面材１２ｂを柔らかいものにするとよい。そのための一手段として、ウレタンフォームを弾力性のあるものにする。具体＊的には、硬さ１．７ｋｇｆ／mm²（ＪＩＳＺ ２１１７に準拠）以下の硬質ウレタンフォームにガラス繊維を含ませるとか、半硬質ウレタンフォームにガラス繊維を含ませるなどの手段があげられる。また、ガラス繊維の含有量を減らすようにしてもよい。上記複数の手段を組合わせてもよい。
【手続補正５】
【補正対象書類名】明細書
【補正対象項目名】００２１
【補正方法】変更
【補正内容】
【００２１】また、芯材１１を柔らかいものにすることによって、まくらぎの横滑りを防止することもできる。具体的には、硬さ１．７ｋｇｆ／mm²（ＪＩＳＺ ２１１７に準拠）以下の硬質ウレタンフォームまたは半硬質ウレタンフォームを用いる。この場合、芯材１１の体積％を５０％以下にするとよい。こうすることによって、道床のバラスが、弾力のある芯材１１の側面から食い込みやすくなるため、まくらぎの横滑りを防止できるとともに、防振性能も向上する。

【手続補正書】
【提出日】平成４年１２月１０日
【手続補正１】
【補正対象書類名】図面
【補正対象項目名】全図
【補正方法】変更
【補正内容】

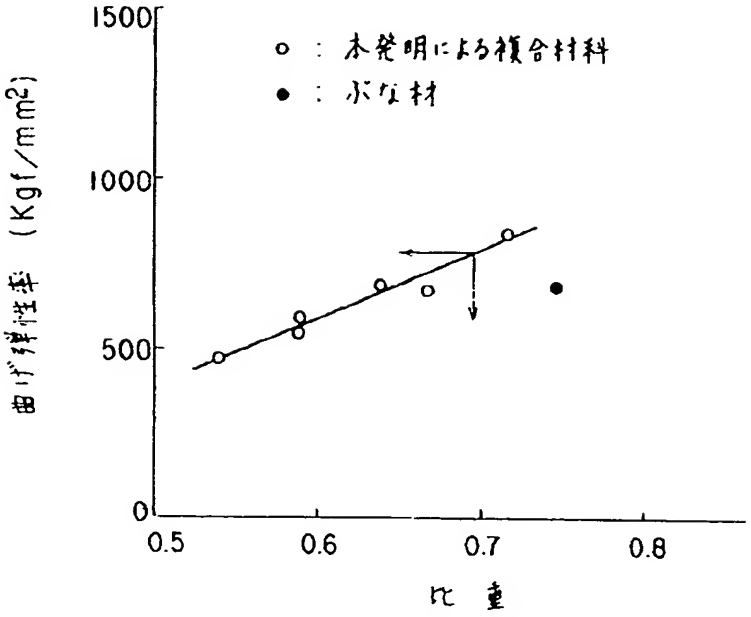
【図１】



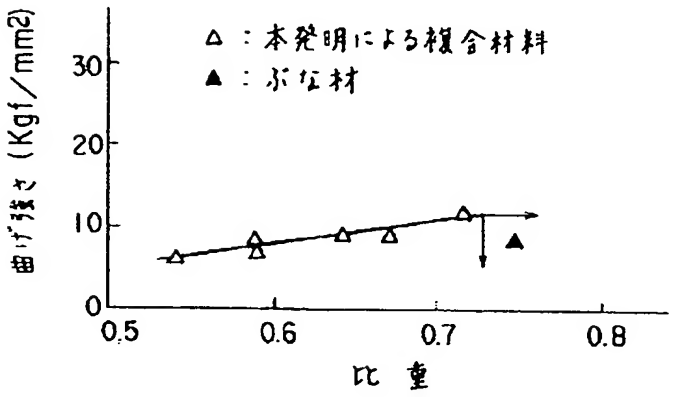
【図２】



【図3】


1500
1000
500
0
0.5
0.6
0.7
0.8
○ ：本発明による複合材料
● ：ぶな材
曲げ弾性率 (Kgf/mm²)
比 重

【図4】


30
20
10
0
0.5
0.6
0.7
0.8
△ ：本発明による複合材料
▲ ：ぶな材
曲げ強さ (Kgf/mm²)
比 重